Institute for Scientific Computing Research

Sabbatical Visitor

Center for Applied
Scientific Computing

Numerical Methods for PDEs, Large Scale Computer Simulations, and Applied Scientific Computations

Raytcho Lazarov

Texas A&M University

Abstract

The researcher shall provide research assistance with projects at Lawrence Livermore National Laboratory National Laboratory (LLNL) that are related to numerical methods for PDEs, large scale computer simulations and applied scientific computations. The Center for Applied Scientific Computing (CASC) at LLNL has a strong and diverse program in design, testing and application of numerical algorithms in science and engineering.

The main direction of the research assistance will be with the following current projects at CASC

- Scaleable Linear Solvers.
- FOSLS (first order systems least squares).
- Modeling Subsurface Flow and Chemical Migration on High Performance Computers.
- Structured Adaptive Mesh Refinement Application.

Specifically, the researcher shall work on the following two topics.

Finite volume element methods for convection–diffusion–reaction problems.
This will include developing and studying various approximation strategies in finite volume methods as locally conservative schemes and also design, testing and implementation of various local error estimators and indicators for adaptive grid refinement (indicators based on the residual, second derivatives, Zienkewicz-Zhu, and hierarchical finite volume element methods). In this space, the research will work to develop a theory for error estimates of finite volumes of higher order, to study the corresponding strengthen Cauchy inequality and to develop the adaptive strategy.

Stabilization of the finite element method via least squares.
The research will focus on the least-squares method for stabilizing finite element approximations of nonsymmetrical and indefinite problems. The main goal will be to address various stabilization approaches in solving convection-dominated diffusion equations. In collaboration with Panayot Vassilevski of CASC, the researcher will investigate steam-line diffusion least squares; the main tool will be multi-level preconditioning/realization of discrete inner product in Sobolev spaces with negative indices, multigrid methods and domain decomposition. Investigators also study elastic deformations of nearly incompressible materials in 3-D, and adaptivity in the context of the least-squares. Additionally, the researcher will interact with CASC to explore the FOSLS philosophy for design and implementation of robust and reliable algorithms for some limiting cases of Bolzman equation.